A Versatile Method for Treating Intracranial Wide-neck Aneurysms: Catheter-assisted Technique of Three variations

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Summary

Successful management of aneurysms of complex morphology depends primarily on adjunct use of balloons or stents. However, these two methods are technically demanding and have higher complication rates. As an alternative to these two techniques, we have used a catheter-assisted technique with a number of cases. It is simple, versatile, and less demanding technically. This technique should be considered as an alternative strategy in cases of wide-necked aneurysms.

Introduction

Trans-arterial embolization has proven to be a safe treatment for intracranial aneurysms [1, 2]. However, wide-necked aneurysms remain technically difficult to treat endovascularly due to a propensity for coil prolapse during the filling of coils [3]. Adjunct use of balloons and stents not only protects the parent arteries but also makes dense packing of the aneurysmal sac feasible for aneurysms with complex morphology [4,5]. However, several authors have reported higher complication rates when balloon-assisted techniques are used in the treatment of intracranial aneurysms [6,7]. Likewise, conjunctive anti-platelet therapy in the stent-assisted method has been associated with a considerable number of peri-procedural and post-procedural hemorrhage events.

Here we present three cases demonstrating this versatile technique using two catheters. Conceptually, the central feature of this technique is the simplification of the devices employed in order to minimize complications. We start by forming a stable basket of two coils with two catheters in the unfavorable aneurysms. If this is not effective, we keep a catheter in the target vessel, either in the parent artery or in a side branch arising from the aneurysmal sac, in order to remodel the morphology of the aneurysm to facilitate the formation of an ideal basket.

Intervention Technique

Case 1. A 50-year-old woman was suffering from a severe headache followed by loss of consciousness. CT showed diffuse subarachnoid hemorrhage and an aneurysm located in the right middle cerebral artery. The aneurysm in the right MCA was clipped. However, control angiography after the surgery showed a residual neck. Immediate embolization was arranged to prevent re-bleeding. The patient was put under general anesthesia. Heparinization was kept at 1.5 to twice baseline of activated partial thrombin time. Six French Envoy (Cordis endovascular, Miami Lakes, FL, USA) were placed in the right internal carotid artery. Simple coiling was attempted but the coil persistently protruded into the parent artery. We thus decided to insert two SL-10 microcatheters (Boston Scientific, Fremont, CA, USA) in-

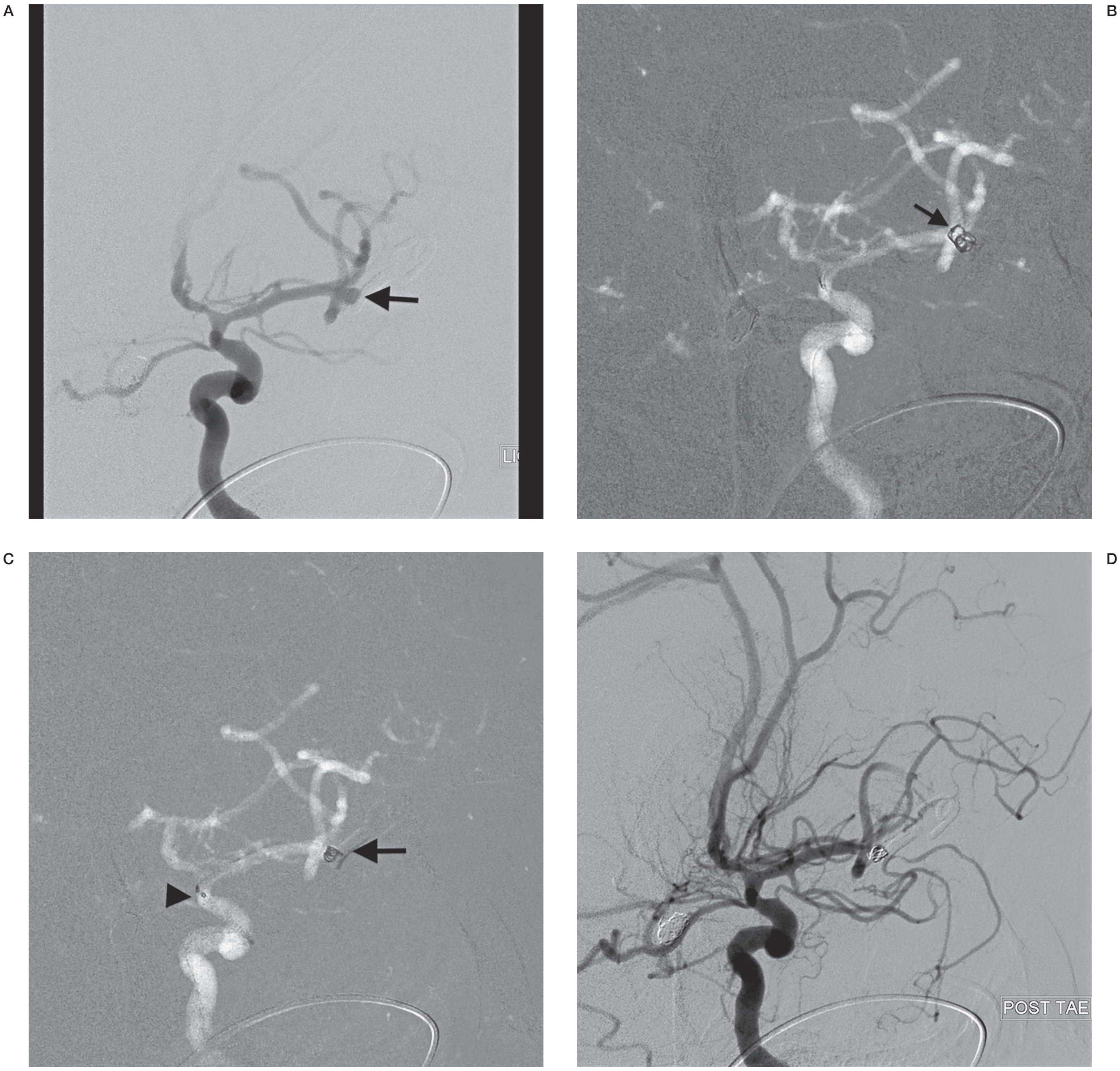

Figure 1 A) Control angiography of a 50-year-old woman after clipping of an aneurysm in the right MCA showed a residual neck (arrow). B) Simple coiling demonstrates prolapsed coil (arrow) outside the parent artery. C) Two catheters were used to construct a stable coil basket (arrow).The proximal markers of two catheters (arrowhead) are shown. D) Control angiography after embolization showed obliteration of aneurysm with preserved parent artery.

to the aneurysmal sac. Then, we deployed two 3D-Guglielmi detachable coils (GDC; Boston Scientific, Fremont, CA, USA) sequentially and detached them simultaneously to form a stable basket. Further coiling was performed to complete the packing (Figure 1).

Case 2. A 76-year-old woman complained of progressively severe headaches over a period of three months. A brain MRI revealed an ophthalmic aneurysm in the left internal carotid artery. The dome of the aneurysm was measured at 7.6 mm at its largest diameter and the neck was measured at 4.5 mm. Endovascular treatment was carried out following the same protocols as for the above case. A 6F Envoy was placed in the left internal carotid artery. We initially attempted to navigate a 4×10 mm

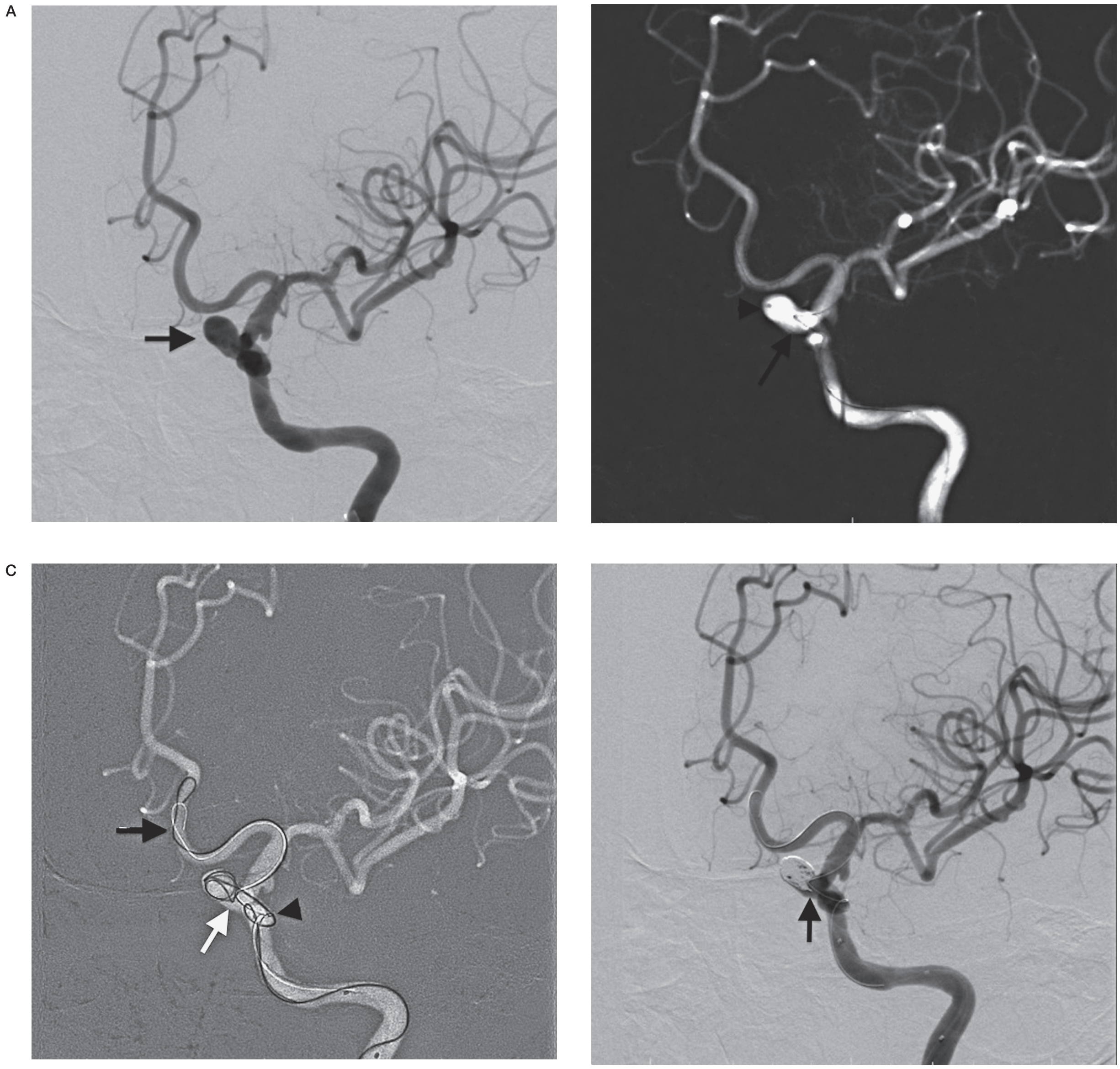

Figure 2 A) Digital subtraction angiography of the left internal carotid artery in a 76-year-old woman showed a wide-neck aneurysm (arrow) in the paraophthalmic region. B) Insertion of a hyperglide balloon was attempted but always herniated into the aneurysm sac (arrow), and caused friction with the aneurysmal neck. Note the presence of another microcatheter within the aneurysm (arrowhead). C) Instead, we used a SL-10 microcatheter with the wire tip in ACA (black arrow), and started to coil with another catheter. Notice the tension of the catheter (arrowhead) due to tortuosity of the vessel, which helps sustain the catheter by counteracting the force of the coil (white arrow). D) Immediate control angiography showed a small notch-shaped basket of the coils (arrow) within the nearly obliterated aneurysm.

hyperglide balloon (ev3, Irvine, CA, USA) to the ophthalmic portion of the ICA (3.6-3.9) mm for protection during coiling but could not pass the aneurysmal neck due to the tortuosity of the internal carotid artery. We exchanged the balloon catheter with another SL-10 microcatheter (Boston Scientific, Fremont, CA, USA) to cross the neck of the aneurysm, and started to coil with a 7×20 mm detachable framing coil (Axium, ev3, Irvine, CA, USA), and then filled this framing coil with smaller coils. Control angiography showed the remodeling effect of the wire in preventing coil protrusion (Figure 2).

Case 3. A 29-year-old man presented suffering from chronic headaches. MR imaging of his brain showed a fusiform aneurysm at the right vertebral artery. The posterior inferior cerebellar artery (PICA) is from the aneurysmal sac. We performed endovascular treatment as described in the first case. A 6F Envoy was placed in the right vertebral artery. Initially, we attempted to utilize a 4×10 mm hyperglide balloon (EV3, Minneapolis, MN, USA) to pass though the right distal vertebral artery (2.7-3.2 mm) to protect the orifice of the PICA, but we were unsuccessful due to the acute angle formed by the aneurysm and the distal parent artery. A microcatheter (Echelon14, MTI-ev3, Irvine, CA, USA) was then navigated over a guidewire (Silverspeed, MTI-ev3, Irvine, CA, USA) to reach the right PICA and was kept in place with an infusion pump, while selection of the aneurysmal sac was achieved with another microcather (Echelon14, MTI-ev3, Irvine, CA, USA). Embolization was commenced by deployment of a coil sized as 9×30 mm and completed with a coil sized as 2×1 mm. The PICA was preserved at the end of the procedure (Figure 3).

Discussion

Treatment of wide-necked aneurysms is often attempted with adjunct devices such as balloons or stents. Temporary inflation of a non-detachable balloon across the aneurysm neck to facilitate optimal coil placement, known as the balloon-assisted technique, has not only demonstrated usefulness in securing placement of the initial coils, but also in preventing the prolapse of the coils. Further studies have also demonstrated a lower compaction rate during follow-up for those aneurysms for which more optimal packing with the aid of balloons was achieved [8,9]. Some concern, however, has been expressed that the adjunctive use of balloons may lead to an increased incidence of thromboembolism, even under optimized anticoagulation [6,10,11]. Other complications such as rupture or vessel dissection have also been reported [12]. More recently, the stent-assisted coiling technique has been described as a treatment method for wide-necked aneurysms. With improvement of materials and conformity of stents, navigation of a stent through the aneurysmal sac is technically less demanding than use of a balloon [13]. Peri- and post-procedural dual antiplatelet therapy does not contribute to intracranial hemorrhage after [14]. However, antiplatelet therapy after stent deployment may still cause clinical dilemmas during the management of extracranial hemorrhage events such as gastrointestinal hemorrhage. Furthermore, a propensity for delayed in-stent stenosis has also been reported [15, 16]. There are three different variations of the catheter-assisted technique. In the first, two catheters are placed into the aneurysm, followed by two coils sequentially or alternatively deployed without detachment to form a coil basket with appropriate distribution for a wide-necked aneurysm, especially for those with a very small dome-to-neck ratio [17]. A potential complication of coil entanglement when filling an aneurysm with multiple coils is the knotting of coils, which makes their advancement or retrieval difficult. If advancement or retrieval becomes impossible, readjustment becomes necessary. Using small, simple helical shape coils rather than large, complex ones reduce the risk of interlocking. In the second variation, a catheter is placed across the neck of the aneurysm as a barrier to prevent coil prolapse [18]. The major advantage of this method is its higher success rate compared to that of a balloon catheter, explained by the easier tracking ability of a microcatheter in navigating tortuous arteries, and by the acute angle formed between the parent artery and the side branch [10]. Some concerns about the stability of the catheters have been raised. However, the supportive power of the catheter can be strengthened by proper selection of wire and catheter based on the location of the aneurysm and related branch arteries. Furthermore, appropriate tension formed between the catheter and wire over the catheter helps to maintain its course and configuration to counteract the force of the coil mass. The third variation of this technique involves placement of a catheter in the branch arising from the aneurysm sac to preserve its patency during coiling [19]. The importance of gentle manipulation of the catheter and wire during navigation through the branch cannot be over-emphasized, especially in cases involving ruptured aneurysms. Overall, all of the catheter-assisted techniques are theoretically less traumatic than use of a balloon while navigating through the aneurysmal neck or sac, and are less likely than the stent-assisted technique to cause stretching or interlocking of coils [20]. They are also less expensive than techniques involving balloons or stents. None of the three variations of the catheter-assisted technique offer known advantages in relation to one another. Regarding long-term recanalization, we do not have sufficient data to draw conclusions, but we do not believe this technique to be the criti-

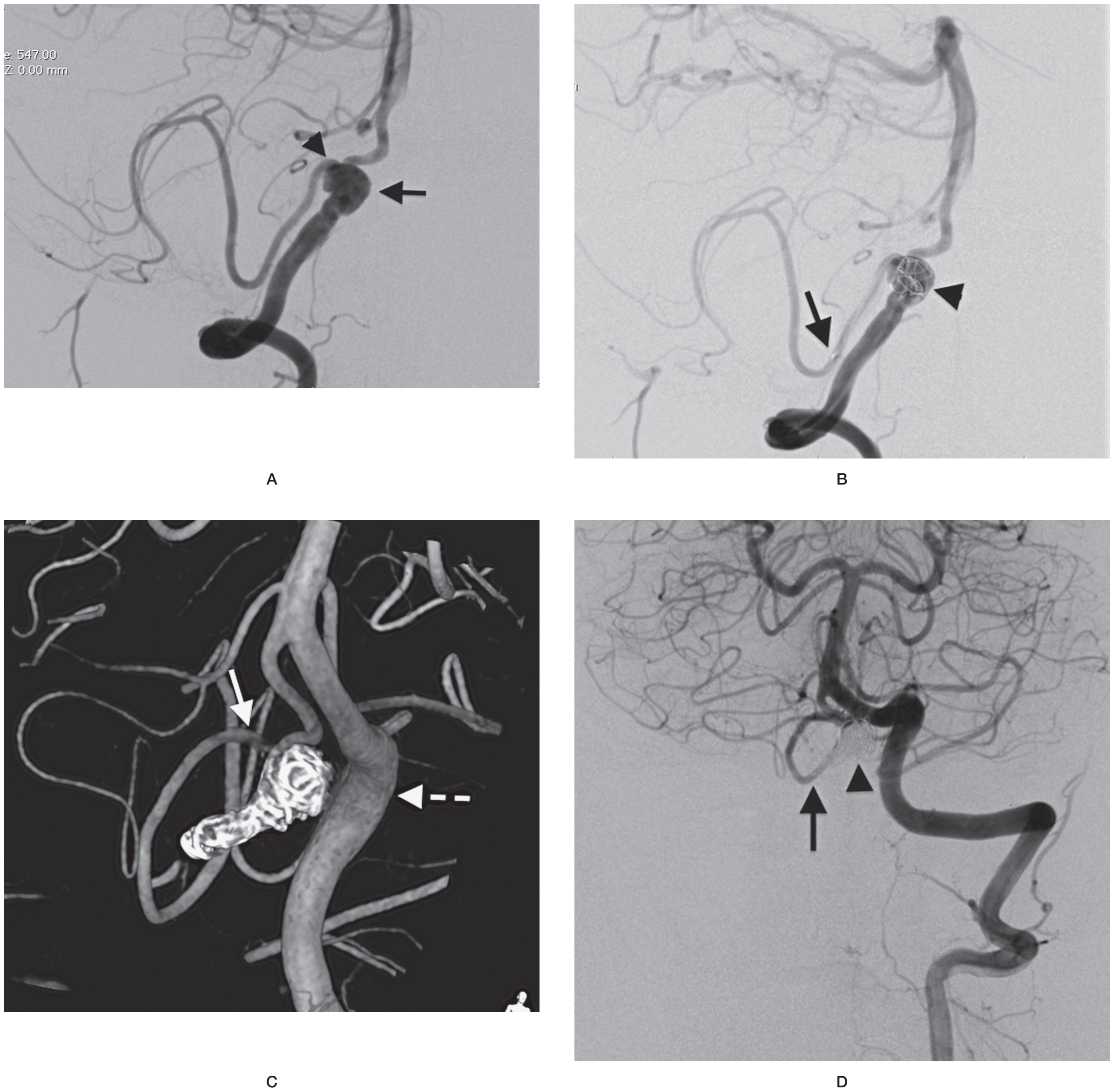

Figure 3 A) Digital subtraction angiography of the right vertebral artery in a 29-year-old man showed a fusiform aneurysm (arrow) incorporated with PICA (arrowhead) from its upper portion. The distal angle formed between the aneurysm and the distal right vertebral artery is acute, and the route is quite tortuous. A balloon-assisted technique was initially attempted but failed (not shown). B) One Echelon-14 catheter was navigated through the aneurysm with its tip (arrow) in the PICA to protect its orifice, followed bythe coiling of the aneurysm (arrowhead) with another catheter. C) Volume rending of immediate rotation angiography showed total obliteration of the aneurysm (arrowhead) with the PICA (arrow) supplied by the contralateral vertebral artery (dashed arrow). D) Control angiography after 3 months shows still stable coil configuration within thrombosed aneurysm (arrowhead) and patency of the PICA (arrow). (PICA: posterior inferior cerebellar artery.)

cal factor in recanalization. Aneurysmal configuration (neck size, location, anatomical relation with the parent artery), hemodynamic factors and immediate coil packing density are likely to be more important factors determining long-term results.

Conclusion

The catheter-remodeling technique is inexpensive and carries fewer peri-procedural risks than either balloon remodeling or stent-assisted methods for embolization of intracranial aneurysms. This technique should be considered as an alternative strategy when simple coiling fails. Although more clinical experience and data on long-term results is required, we believe this technique may offer a reliable, versatile alternative for the endovascular therapy of wide-necked aneurysms.

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